MathUser

The Wolfram Research Newsletter for Mathematica™ Users

Mathematica Days —More to Come

Winter 1994

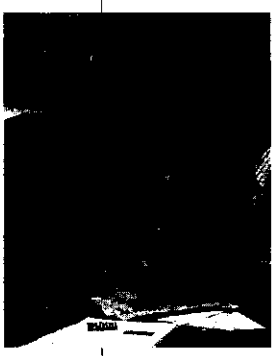
Mathematica Applications Library

How to Get the X Front End

Electronic Publishing with MathSource

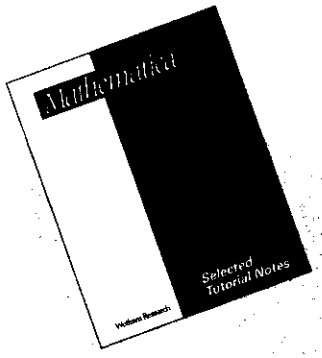
Feature Focus: Customizing Mathematica with init.m

Over a thousand people attended the five *Mathematica* Days held earlier this fall in the United States and Europe. The *Mathematica* Days were intended for new *Mathematica* users and other people interested in *Mathematica*. The Days focused on elementary and intermediate tutorials, covering introductory *Mathematica* programming, graphics, notebooks, and *MathLink*. Attendees also received practical information from fellow *Mathematica* users in the areas of engineering, finance, and education. A special highlight was that each day opened with a talk by Stephen Wolfram, entitled "*Mathematica* and the Future of Technical Computing."



Attendees said that they now feel better equipped to apply *Mathematica* to daily projects to enhance their productivity. Laurie Iten, a professor of biological sciences at Purdue University, said, "I wanted to see how other people are using the program and I did. I'm looking forward to incorporating *Mathematica* into my research."

Mathematica Days attendees told us that their colleagues are also interested in learning more about *Mathematica*. When asked what is the best way for their colleagues to learn about *Mathematica*, they responded, "Attend a *Mathematica* Day."



Mathematica Days attendees also had the opportunity to buy the new Wolfram Research publication, *Selected Tutorial Notes*, a collection of tutorial notes from previous conferences. If you are a new user, the *Selected Tutorial Notes* are a great way to get started with *Mathematica*. To order a copy of the *Selected Tutorial Notes*, call 217-398-0700. (In Europe call +44-(0)993-883400).

Positive feedback from those who attended, and requests from others who weren't able to make it, have encouraged us to hold future *Mathematica* Days in more locations throughout the world. If you or someone you know would like to receive information about future *Mathematica* Days near you, call Wolfram Research or send us an email message to mdays@wri.com to add your name to our mailing list. As soon as dates and locations for future Days are scheduled, we will mail a brochure and registration form to you.

Lecture Tour In Japan

Because of the success of the *Mathematica* Days, we have scheduled a series of "mini" *Mathematica* Days for late January 1994 throughout Japan. Keep an eye out—more information will be sent to local *Mathematica* users soon.

About *MathUser*

MathUser is published by Wolfram Research to provide news and information about *Mathematica* to registered *Mathematica* users. *MathUser* is also available free of charge to other people interested in *Mathematica*. To be added to the list of subscribers or to submit a change of address, send your postal address information to mathuser@wri.com, or call 217-398-6500. (In Europe, fax +44-(0)993-883800.) Note that *MathUser* is sent to your registration address, the same address where all other *Mathematica* information and mailings are sent.

Electronic copies of back issues of *MathUser* are available on *MathSource*. This issue of *MathUser* is *MathSource* item 0205-771. For paper copies of back issues, send an email request to mathuser@wri.com.

Your comments and suggestions are important to us. Send letters to the editor at the address below. We are always interested in hearing ideas for topics to be covered in *MathUser*.

How to Contact Us

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On the Cover

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New Applications Library Set for Release

Professionals use *Mathematica*'s numerical, symbolic, graphics, and programming capabilities to solve problems in their fields every day. To make it even easier for professionals to incorporate *Mathematica* in different areas, Wolfram Research has introduced the *Mathematica* Applications Library. The Applications Library supplements tools that *Mathematica* already contains with profession-specific notebooks and packages. The notebooks contain examples that show and describe specific techniques for using *Mathematica*. The packages prede- [illegible] used in various fields.

The first two available volumes of the Applications Library are the Electrical Engineering Pack and the Finance Pack. These volumes can be used in many ways and provide users with

- ready-to-use *Mathematica* functions
- introductory tutorials on a given topic
- examples of *Mathematica* programming
- a core for user algorithms
- ideas for project documentation in notebook format

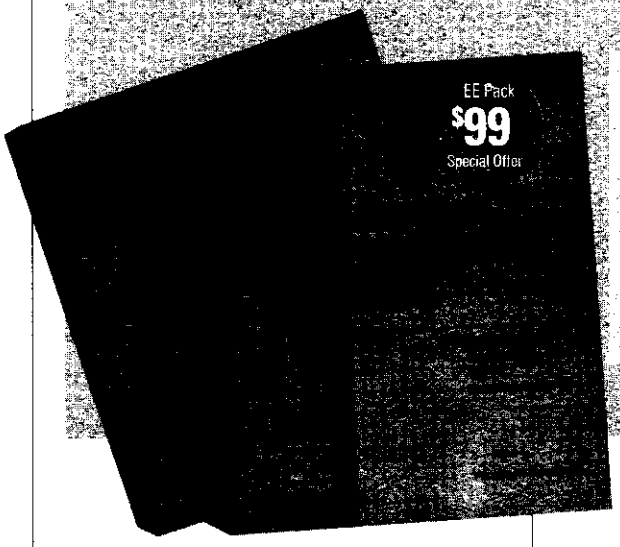
Electrical Engineering Pack

The Electrical Engineering Pack is a collection of notebooks and packages that cover electrical engineering problems, ranging from elementary to advanced topics. Examples, drawn from circuit analysis, transmission line theory, and antenna analysis, show how to use *Mathematica* in electrical engineering.

Finance Pack

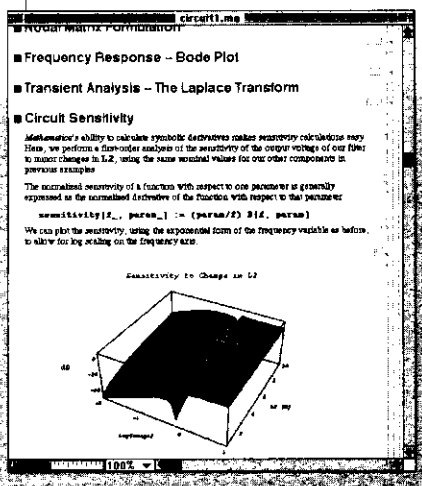
The *Mathematica* Finance Pack is designe for traders, investment analysts, portfoli managers, and others in the financial community who want to use *Mathematic* to analyze financial data and design strategies. Individual investors, as well a research staff from small brokerage houses to large financial institutions, wil find this toolkit valuable.

Topics covered in the Finance Pack include interest rates, bonds, general cash flow, options, and finance calenda computations. The specialized tools cover term structure of interest rates an all commonly used sensitivity function needed for risk management.



How to Order a Library Volume

Order a volume and start increasing your productivity today. For a limited time, Wolfram Research is offering the Electrical Engineering Pack at an introductory price of $99 (regularly $195). This offer ends January 31, 1994. The Finance Pack is available for $395. Both volumes run on Microsoft Windows, Macintosh, and Unix. To order, contact us at 217-398-0700. (In Europe, call +44-(0)993-883400.)



The Electrical Engineering Pack includes examples from:

- Mesh Circuit Analysis
- Nodal Circuit Analysis
- Bode Plots
- Laplace Transforms
- Circuit Sensitivity Analysis
- Ideal Diode and Bipolar Transistor Models
- Chaotic Behavior in a Nonlinear Circuit
- Passive Component Noise
- Amplifier Noise Figure
- Harmonic Distortion
- Crossover Distortion
- Clipping Distortion
- Resistor Selection
- Y to S Parameter Conversion
- Project Documentation
- Symbolic Derivation of Transmission Line Parameters
- Analysis of Reflections Using Animations
- Suppression of Line Ringing by Lossy Lines
- Matrix Techniques for Microwave Transmission Line Analysis
- Dispersion in Dielectric Waveguide Lines
- Smith Chart Design Tools

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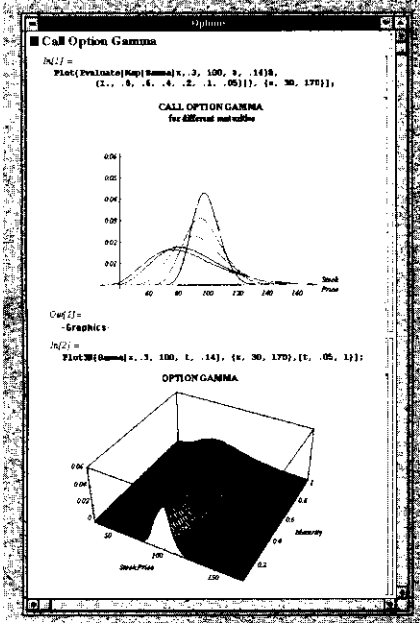
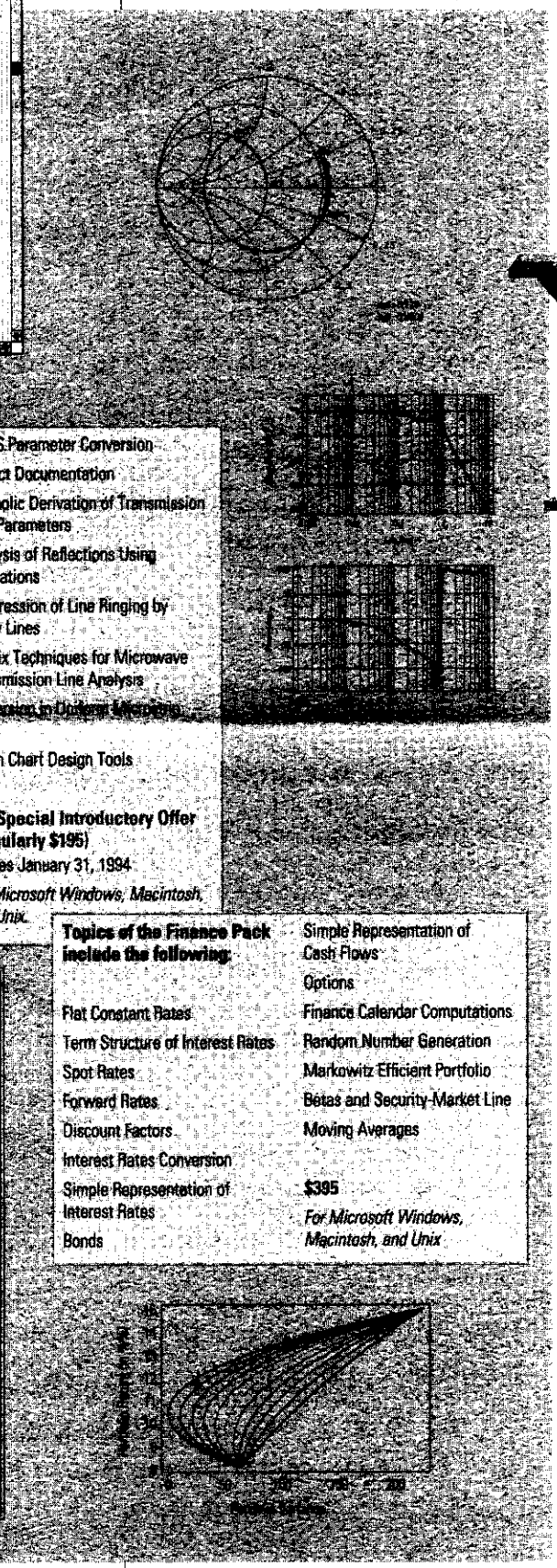


Topics of the Finance Pack include the following:

- Flat Constant Rates
- Term Structure of Interest Rates
- Spot Rates
- Forward Rates
- Discount Factors
- Interest Rates Conversion
- Simple Representation of Interest Rates
- Bonds
- Simple Representation of Cash Flows
- Options
- Finance Calendar Computations
- Random Number Generation
- Markowitz Efficient Portfolio
- Betas and Security Market Line
- Moving Averages

$395
For Microsoft Windows, Macintosh, and Unix



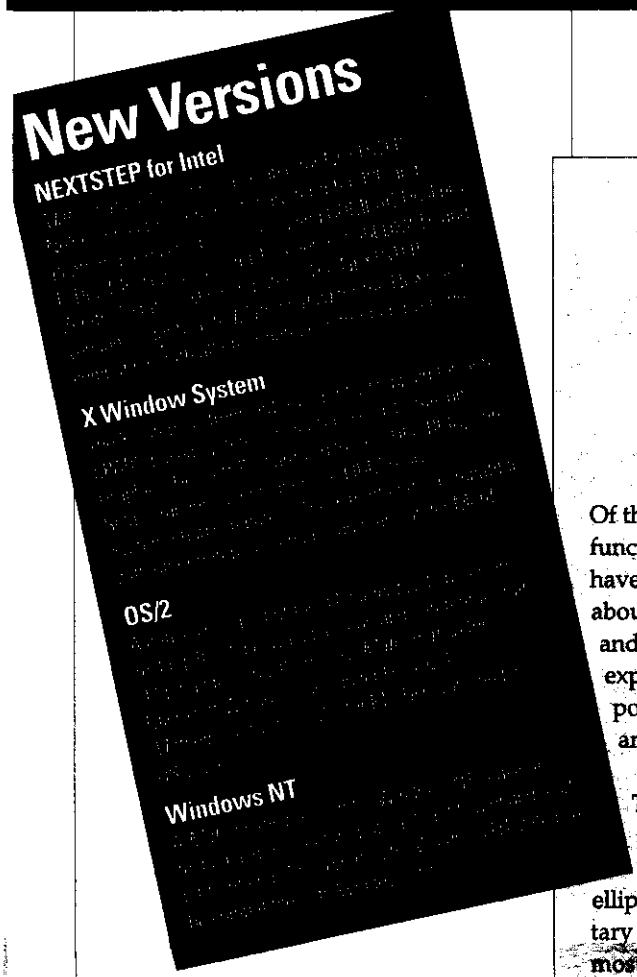
How to Get the X Front End

Shipments of the *Mathematica* X front end recently began for Sun SPARC-based systems (under Sun OS 4.1), Silicon Graphics, Hewlett-Packard 700 Series, DEC MIPS, Sun Solaris (2.0 or higher), and IBM RISC System/6000 computers, providing notebooks, a function browser, and on-line help to Unix users. *Mathematica* notebooks are interactive documents in which a user can combine text, calculations, and graphics. Notebooks are also transferable between platforms—a notebook created on a Unix machine, for example, can be used on a Macintosh, or vice versa.

How can you get the notebook front end on your workstation as soon as possible? The answer is *Mathematica Plus*, the automatic customer update program for *Mathematica*. If you have bought a subscription to *Mathematica Plus* for one of the six platforms listed above, you will automatically receive a complimentary X Front End Update Kit. This kit is not considered one of the two updates regularly provided under the *Mathematica Plus* program, so you can expect to receive two other updates in addition to this kit. (Please note that you are only eligible to receive the update kit if you bought a full *Mathematica Plus* subscription.)

If you haven't yet purchased a subscription to *Mathematica Plus* for one of the platforms mentioned above, you can still subscribe by December 31, 1993 to receive your complimentary X Front End Update Kit and two additional *Mathematica* updates as soon as they are released.

To subscribe to *Mathematica Plus*, contact Wolfram Research at 217-398-0700 or send email to info@wri.com. In Europe, call +44-(0)993-883400 or send email to info-euro@wri.com.



MathLink Developer Kit for Microsoft Windows

Of the infinite number of mathematical functions that exist, only several hundred have been given names. Everyone knows about the "elementary" functions: circular and hyperbolic trigonometric functions, the exponential function, their inverses, and polynomial functions. All other functions are considered "special" functions.

There are several broad classes of special functions, including the special functions of mathematical physics, elliptic integrals, and integrals of elementary functions. *Mathematica* contains the most important special functions in these and other classes. For example, *Mathematica* has groups of Bessel and elliptic functions, as well as the Gamma and Zeta functions.

Mathematica has several principles that apply to the evaluation of mathematical functions:

- *Mathematica* algorithms evaluate each function throughout the complex plane to any precision.
- When given a machine number as an argument, *Mathematica* attempts to return the machine number closest to the value of the function at that argument.
- *Mathematica*'s interface is designed to make it easy to use special functions as buildings blocks of other functions.
- *Mathematica*'s algorithms are designe be efficient and well-conditioned (*i.e.*, insensitive to errors either in the argu to the function or in values intermedi the calculation).

In addition, *Mathematica* uses meta-alg rithms to select the best of several algo for any particular set of parameters. Fo example, if the best algorithm for evalu e^x were the series expansion, *Mathemat* would distinguish between the cases x and $x>0$. The series expansion at $x = 12$ fers from catastrophic cancellation of d 1 – 12. + 72. – 288. + ... + 17062.8 – 1861 18613.9 – 17182.1..., but $e^{-x} = 1/(e^x)$ and + 12. + 72. + 288. + ...) involves no cance

Occasionally all algorithms are more il ditioned than the function itself, and d will be lost in cancellation. *Mathematic* arbitrary-precision arithmetic monitor precision of the calculation to know hc many extra digits are needed when ree ating the function with higher precisio *Mathematica* automatically reevaluates function with higher precision to comp sate for any ill-conditioning of the algc in excess of the ill-conditioning of the tion. However, when the function itsel conditioned, the algorithm does not gi more digits than justified by the functi

For more information about special fu tions in *Mathematica*, see Section 3.2.10 Stephen Wolfram's book, *Mathematica: System for Doing Mathematics by Compu* Second Edition.

The closest machine number to erf(10) is 1.

```
Erf[ N[10] ]
1.
```

Considerably more than 20 digits are justified by a 20-digit approximation to erf(10).

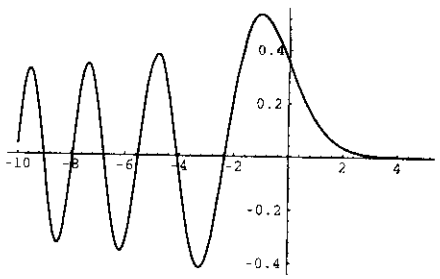
```
Erf[ N[10, 20] ]
0.99999999999999999999999999999999999999999999998
```

`Log[Gamma[z]]` restricts the imaginary part to be between $-\pi$ and π and results in the complex plane being cut by infinitely many curved branch cuts. By analytic continuation, `LogGamma[z]` just has a branch cut along the negative real axis.

```
LogGamma[ 2.3 + 8.9I ]
-9.11504 + 13.207 I
```

The Airy Ai function is related to Bessel functions of order 1/3. The Airy Ai function can be used to describe the probability of finding a quantum particle, such as an electron, at various distances from a linear potential barrier.

```
Plot[ AiryAi[x], {x, -10, 5} ]
```

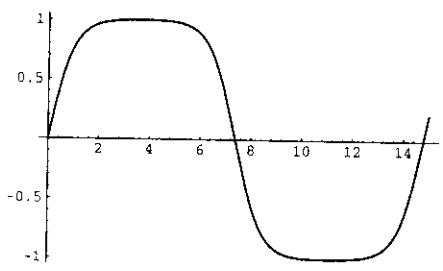


Reimann's ζ function can be evaluated anywhere in the complex plane. This is near the first zero on the critical line with an imaginary part greater than 1000. The precision of the result is only as high as justified by the input.

```
Zeta[ 1/2 + 1001.3494826377827371221033 I]
-2. 10^-23 - 3. 10^-23 I
```

`JacobiSN[ ]` is an elliptic function related to the motion of a simple pendulum. When x is near 1, the function corresponds to a pendulum that swings almost from vertical to vertical, nearly balancing at each end of the swing.

```
Plot[ JacobiSN[x, .99], {x, 0, 15} ]
```



Updating Registered User Information

Keeping your registration information up to date helps us manage license information more efficiently, issue passwords faster, and send update and new product information. Please take a moment to check the name and address on the mailing label of this issue of *MathUser*. (Note that we send *MathUser*, update information, and all other *Mathematica* mailings to the same address.) An R after your name indicates that you are a registered user. An N after your name indicates that you are a *MathUser* subscriber, but not a registered user.

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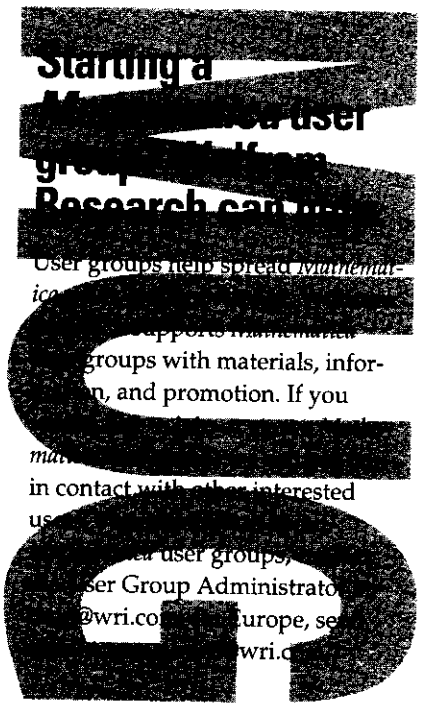
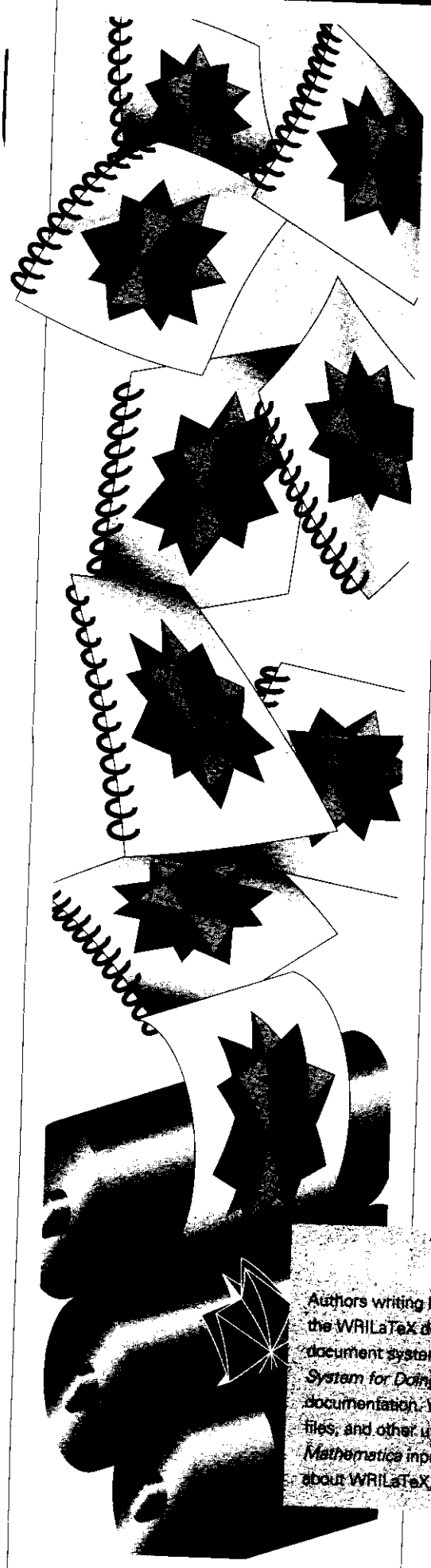
CHAMPAIGN, IL  61820-7237
```

Please contact User Services if

- the address information is incorrect
- you are a registered user, but do not have an R code
- the person on the label is no longer with your organization, or
- you receive more than one copy of *MathUser*

You can reach User Services by fax at 217-398-0747 or by email at register@wri.com. As always, we welcome your comments and suggestions.





Electronic Publishing with *MathSource*

As more books are supplemented with *Mathematica* packages and notebooks, authors and publishers need a convenient, effective way to publish electronically. The best way to publish electronic supplements, periodicals, and documentation is with *MathSource*, the electronic resource for *Mathematica*-related materials.

Here are some of the important advantages of publishing with *MathSource*.

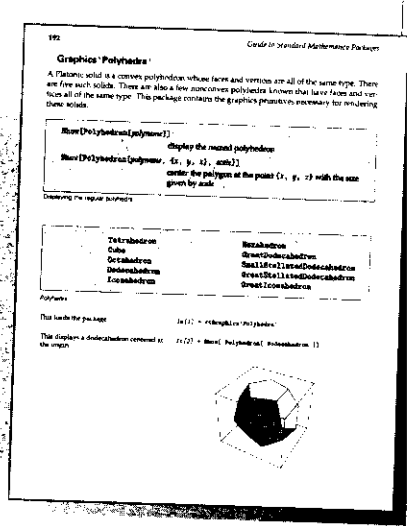
- *MathSource* reaches *Mathematica* users around the world, averaging 2000 sessions weekly from over 50 countries.
- *MathSource* is accessible by email, direct dialup, anonymous ftp, and Gopher.
- *MathSource* sends materials in formats appropriate for different computer systems, making it unnecessary for publishers to make different versions of supplements. *MathSource* can send files formatted for Macintosh, DOS, and Unix computers, and also send NeXTmail.
- Users can search *MathSource* by keyword to easily find all *Mathematica* materials on a topic.
- Authors and publishers save the production cost of packaging disks with books.
- To distribute a new version or bug fix, an author has only to submit updated materials to *MathSource*, instead of mailing disks to each person who bought the book. *MathSource* can automatically notify users when an author updates materials, ensuring that everyone has the most current version.

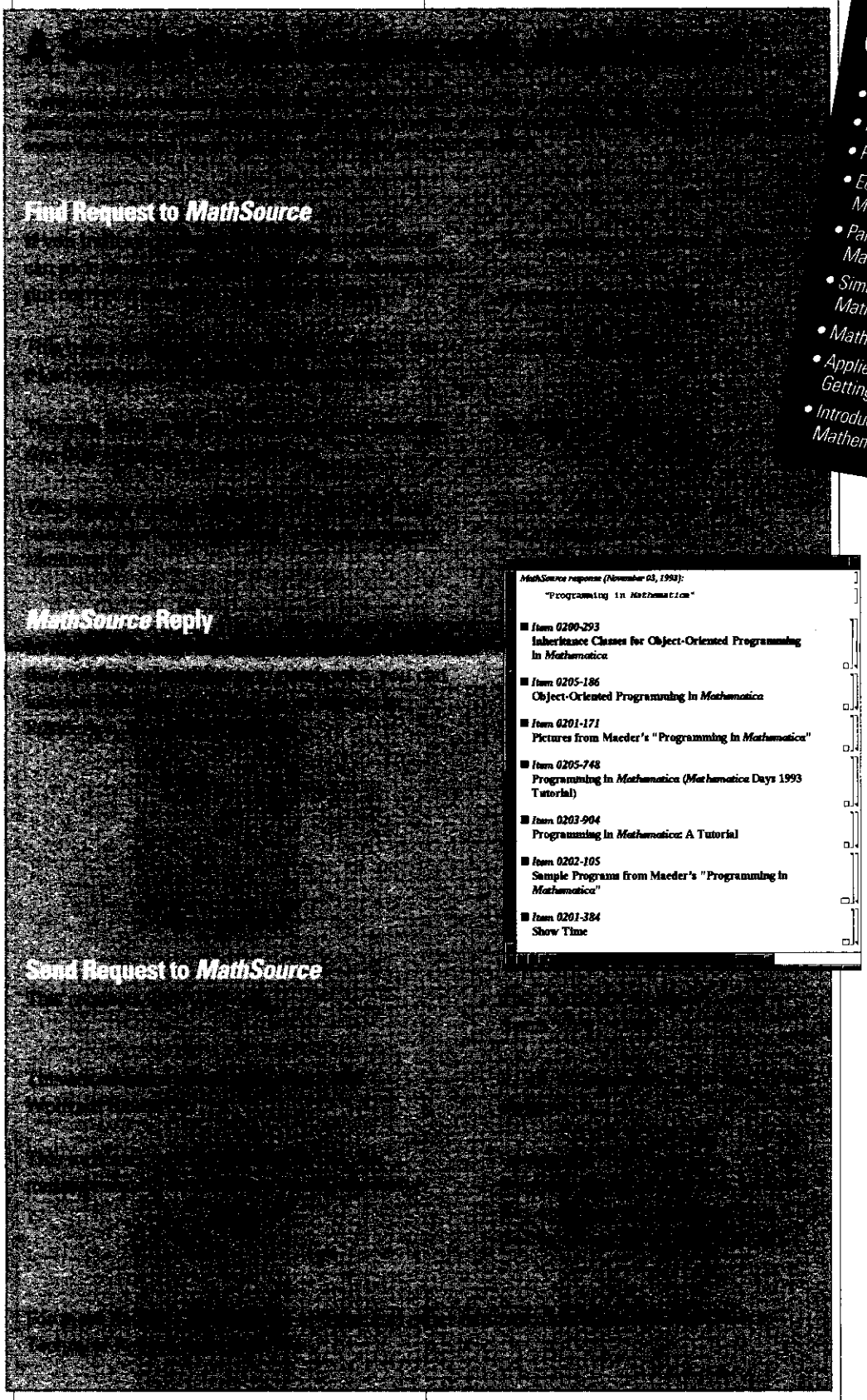
How to Publish with *MathSource*

Do you have materials that you would like to publish with *MathSource*? You can send us the materials via email, on disk, or give the address of an anonymous ftp site. When submitting materials to *MathSource*, be sure to include the title of the material, an abstract, suggested keywords, and who to contact for more information about the materials.

If you would like more information about publishing *Mathematica*-related materials with *MathSource*, send email to the *MathSource* administrator at ms-admin@wri.com, or call 217-398-0700.

Authors writing books or technical reports based on *Mathematica* can get the WRILaTeX document system from Wolfram Research. The WRILaTeX document system was used to produce Stephen Wolfram's *Mathematica: A System for Doing Mathematics by Computer*, and other *Mathematica* documentation. WRILaTeX consists of LaTeX style files, macro definitions files, and other utilities that make it easy for authors to incorporate *Mathematica* input and output into a TeX-based document. For information about WRILaTeX, send email to wrilatex@wri.com.





MathSource response (November 03, 1993):

"Programming in Mathematica"

- *Item 0200-293*
  Inheritance Classes for Object-Oriented Programming in *Mathematica*
- *Item 0205-186*
  Object-Oriented Programming in *Mathematica*
- *Item 0201-171*
  Pictures from Maeder's "Programming in *Mathematica*"
- *Item 0205-748*
  Programming in *Mathematica* (*Mathematica* Days 1993 Tutorial)
- *Item 0203-904*
  Programming in *Mathematica*: A Tutorial
- *Item 0202-105*
  Sample Programs from Maeder's "Programming in *Mathematica*"
- *Item 0201-384*
  Show Time

A Few Electronic Supplements Now on *MathSource*

- *The Mathematica Journal*
- *Mathematica in Action*
- *Programming in Mathematica*
- *Economic and Financial Modeling with Mathematica*
- *Partial Differential Equations with Mathematica*
- *Simulating Neural Nets with Mathematica*
- *Mathematica in Education*
- *Applied Mathematica: Getting Started, Getting It Done*
- *Introduction to Programming with Mathematica*

Here are two ways to get a faster reply from *MathSource:*

1. Send each **`Find`** command in a separate message. Because *MathSource* processes your entire message before returning a response, a single message containing several **`Find`** commands can take longer than several messages with one **`Find`** command each.

2. Send *MathSource* as few keywords as possible for each item. For example, to find information on modified Bessel functions, send the command **`Find Bessel`** instead of **`Find Modified Bessel Function`**. Because *MathSource* does a full search for each keyword in your message, sending one keyword for an item will get results faster than several keywords.

New Books

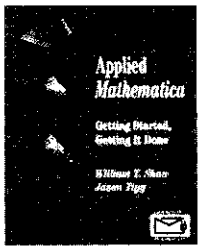
[illegible] new *Mathematica* [illegible] from [illegible] tutorials in programm[illegible]g, mathemat- [illegible]*athematica*, to [illegible] professional reference [illegible]oks. For [illegible], contact the p[illegible]s or any techni- [illegible] boo[illegible]re.

English Titles

Applied Mathematica: Getting Started, Getting It Done

William T. Shaw and Jason Tigg (Addison-Wesley, ISBN 0-201-54217-X)

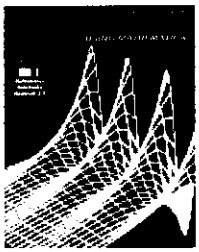
Shows how to solve complex, practical problems in engineering, finance, environmental engineering, and image processing. Provides a quick start for scientists and engineers. Electronic accompanying materials are available on *MathSource*.



Calculus Using Mathematica

K.D. Stroyan (Academic Press)
ISBN 0-12-672971-9 (with Macintosh disks)
ISBN 0-12-672972-7 (with IBM/DOS disks)
ISBN 0-12-672973-5 (with NeXT disks)

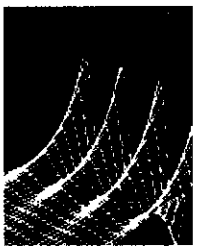
Textbook for three-semester undergraduate calculus. Fully integrates *Mathematica* into the primary text and comes with *Mathematica* notebooks on disk.



Scientific Projects and Mathematical Background for Calculus Using Mathematica

K.D. Stroyan (Academic Press, ISBN 0-12-672975-1)

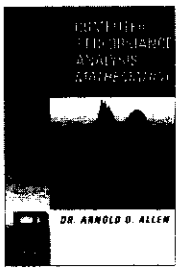
A companion workbook to *Calculus Using Mathematica*.



Introduction to Computer Performance Analysis with Mathematica

Arnold Allen (Academic Press, ISBN 0-12-051070-7)

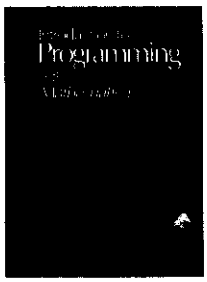
Beginner's guide to computer performance analysis. Topics include benchmarking, measurement requirements, simulation, and forecasting. Comes with *Mathematica* files on disk.



Introduction to Programming with Mathematica

Richard J. Gaylord, Sam N. Kamin, and Paul R. Wellin (TELOS/Springer-Verlag, ISBN 0-387-94048-0)

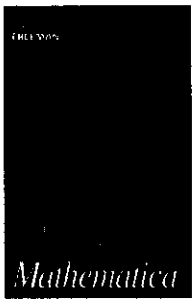
A textbook introducing programming in the *Mathematica* language. Emphasizes the functional and rule-based styles unique to the *Mathematica* programming language. Does not assume prior programming or *Mathematica* experience. Comes with electronic supplement.



Simulating Neural Networks with Mathematica

James A. Freeman (Addison-Wesley, ISBN 0-201-56629-X)

Introduces the operations and application of neural networks in the context of *Mathematica*'s programming language. Shows professionals and students how to use *Mathematica* to simulate neural network operations to assess neural network behavior and importance. Electronic materials available on *MathSource*.



Non-English Titles

Erste Schritte mit Mathematica [First Steps in Mathematica]

W. Burkhardt (Springer-Verlag, ISBN 3-540-56650-3)

An introduction to *Mathematica* designed for independent study or introductory courses. Emphasizes the most important areas of application through the use of problems in high school and university mathematics. (in German)

Informatik für Mathematiker und Naturwissenschaftler: Eine Einführung mit Mathematica [Computer Science for Mathematicians and Scientists: An Introduction with Mathematica]

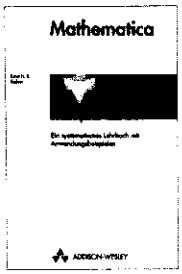
Roman Maeder (Addison-Wesley, ISBN 3-89319-519-X)

A textbook for introductory computer science, especially for mathematicians, scientists, and engineers. Treats traditional computer science topics and shows how modern computer-based tools can be used to do scientific computation. (in German)

Mathematica: Ein systematisches Lehrbuch mit Anwendungsbeispielen [Mathematica: A Comprehensive Guidebook with Practical Examples]

Ernst H.K. Stelzer (Addison-Wesley Deutschland, ISBN 3-89319-495-9)

Introduction to *Mathematica* with applications based on problems taken from physics, chemistry, and biology. Special emphasis on analysis, linear algebra, and numerical mathematics. (in German)



Translations

Mathematica griffbereit, Version 2 [Mathematica: Quick Reference, Version 2]

Nancy Blachman (Verlag Vieweg, ISBN 3-528-06524-9) (in German)

Mathematica in Aktion [Mathematica in Action]

Stan Wagon (Spektrum Akademischer Verlag, ISBN 3-86025-041-8) (in German)

Forthcoming Books

These books will be available in early 1994.

Animating Calculus

Ed Packel and Stan Wagon (W.H. Freeman, ISBN 0-7167-2428-6)

A supplement for first-year calculus. Contains a series of 22 *Mathematica* notebooks exploring topics in calculus of a single variable.

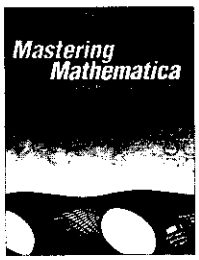
Grafik mit Mathematica [Graphics with Mathematica]

Ralf Schaper (Addison-Wesley Deutschland, ISBN 3-89319-612-9)

Mastering Mathematica: Programming Methods and Applications

John Gray (Academic Press Professional, ISBN 0-12-296040-8)

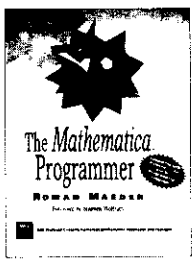
Discusses functional, rule-based, procedural, and object-oriented programming with *Mathematica*. Also covers graphics programming and writing *Mathematica* packages. Comes with electronic supplement.



The Mathematica Programmer

Roman Maeder (Academic Press Professional, ISBN 0-12-464990-4)

Covers the use of *Mathematica* as a programming language. Topics include object-oriented programming, abstract data type design, relational databases, minimal surfaces, and fractal curves. Comes with electronic supplement.



Revised Edition of Mathematica by Example

Martha Abell and Jim Braselton (Academic Press Professional, ISBN 0-12-041530-5)

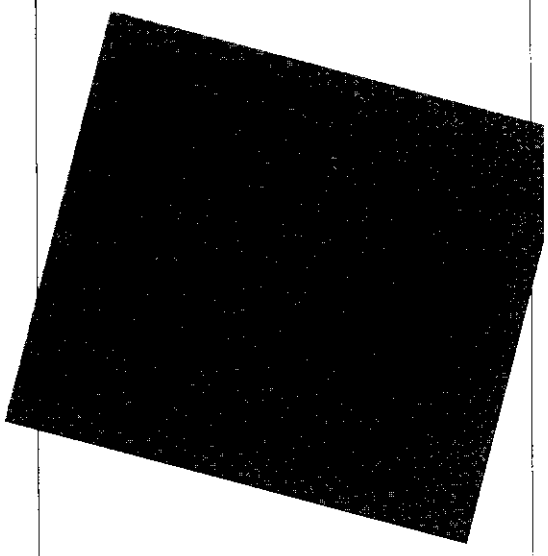
Compatible with *Mathematica* Version 2.2 and shows fundamental *Mathematica* techniques for the beginning user. Topics covered include calculus, linear algebra, differential equations, and discrete mathematics.

Quantum Methods with Mathematica

James M. Feagin (TELOS/Springer-Verlag, ISBN 0-201-58221-X)

For students and experienced professionals who would like to explore quantum physics using *Mathematica*. Divided into two parts: Systems in One Dimension, and Quantum Dynamics. Comes with an electronic supplement.

In addition to these books, which feature special topics with *Mathematica*, there are many books that come with *Mathematica* supplements. In the next issue of *MathUser*, we will list books that use *Mathematica*. If you have written a book that comes with a *Mathematica* supplement, please tell us about it by sending email to mathuser@wri.com, or fax to 217-398-0700.



Customizing *Mathematica* with init.m

You can customize your version of *Mathematica* by changing init.m, an initialization file loaded when *Mathematica* starts up. By writing a new init.m file, or changing the default init.m, you can set *Mathematica* to

- prompt users for different option settings while the kernel is launching
- automatically load packages and launch *MathLink* applications you use every day instead of manually loading them
- print a message as *Mathematica* starts up; for example, a network administrator might add a `Print` statement to init.m that users will see when starting the network copy of *Mathematica*

Consider a few things when writing init.m files:

- If you are using *Mathematica* on a network, it is best to create an additional init.m file for your home directory instead of changing the network default init.m. However, it is possible to load both the custom and default init.m files.
- If you are the only user of a copy of *Mathematica* you may prefer to modify the default init.m. However, be careful when removing commands from the default init.m.
- The directory in which you place a custom init.m will vary with each platform because packages and files are stored differently from platform to platform.

For more information about writing a custom init.m file or loading multiple init.m files, see "Customizing *Mathematica* with init.m" available from *MathSource*, item 0205-838.

A sample custom init.m

This tells a user that *Mathematica* is loading a custom init.m.

```
Print[""];
Print["Running Mathematics Department custom init.m..."]
```

This automatically loads `Graphics`Animation`` and `Graphics`Graphics``.

```
Print["Loading Graphics`Animation` and Graphics`Graphics`..."]
<<Graphics`Animation`;
<<Graphics`Graphics`;
```

This asks the user whether or not to load `Geometry`Polytopes``.

```
If[ MatchQ[ InputString["Load Geometry`Polytopes`?
Y/N (default = no):"],
     "y" | "Y" | "yes" | "Yes" | "YES"],
          <<Geometry`Polytopes`];
```

This prompts the user for a page width value.

```
SetOptions[$Output, PageWidth -> Input["Enter the Page Width
(Number of Characters):"] ]
```

This installs the *MathLink* application `mlprogram`.

```
Install["mlprogram"]
```

This is a message to users from the network administrator.

```
Print[ "An electronic version of 'New Features in \n
      Version 2.2' is in /Documentation."]
```

On Unix platforms, this loads the default init.m file.

```
Block[{$Path = DeleteCases[$Path, "." | "~"]},
  Get["init.m"]]
```

Here's how this custom init.m will start up *Mathematica*

```
server[1]> math
Mathematica 2.2 for NeXT
Copyright 1988-93 Wolfram Research, Inc.

Running Mathematics Department custom init.m...
Loading Graphics`Animation` and Graphics`Graphics`...
Load Geometry`Polytopes`?  Y/N (default = no):n
Enter the Page Width (Number of Characters):60
An electronic version of 'New Features in
 Version 2.2' is in /Documentation.

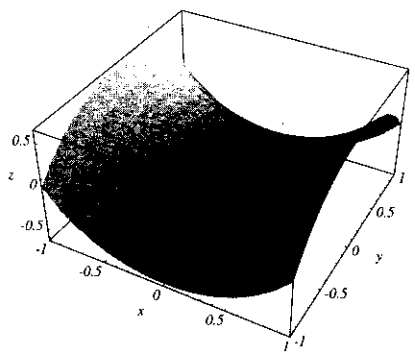
 In[1]:= 2 + 2

 Out[1]= 4
```

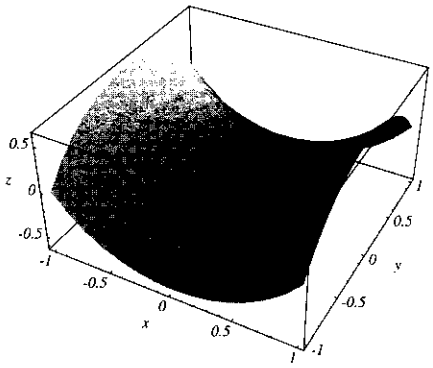
Q: How can I combine a surface plot (with axes labels and ticks) with a `Text` graphic using `Show`? I tried to do this but my plot contains only the surface plot and the text.

A: When `Show` receives a number of graphics objects as input, it converts them to the same type of graphics object. For example, if you combine a `SurfaceGraphics` object with a two-dimensional graphics object, *Mathematica* converts the `SurfaceGraphics` object to a `Graphics` object. *Mathematica* only converts the primitives of the `SurfaceGraphics` object and not the *options*, consequently losing the axes and labels. The simple way to keep the axes and labels is to render everything as a three-dimensional object. Here's an example:

```
surface =
Plot3D[Log[Cos[y]/Cos[x]],
{x,-1,1}, {y,-1,1},
 BoxRatios->{1,1,.5},
DefaultFont->{"Times-Italic",
10},
AxesLabel->{"x","y","z"},
Mesh->False]
```




```
Show[ {surface,
Graphics3D[Text["saddle
point", {0,0,.1}]]} ]
```



Using the `Show` command, `surface`, a three-dimensional object, is combined with a `Graphics3D` object, so the axes and labels are kept.

Q: I have a lab of 100 Macintosh computers. I'd like to be able to run *Mathematica* from any 50 of the computers at the same time. How can I do this?

A: A network license enables you to do this. You can buy a network license for the number of copies you would like to run simultaneously and run *Mathematica* from either a network server or from each individual machine.

You have three options for installing and running *Mathematica* under a network license.

- Install *Mathematica* on each machine covered by the license. This requires that you install the network license password on each machine. *Mathematica* usually runs fastest when installed on each machine.
- Install *Mathematica* on a file server, start it up, and enter the password when *Mathematica* asks for it. Then copy *Mathematica* to each machine. Before copying *Mathematica* from the file server, move "*Mathematica* Kernel Prefs" from the Preferences folder (in the System folder) to the *Mathematica* folder. "*Mathematica* Kernel Prefs" is a file that contains password information. By copying this file along with *Mathematica*, you will not need to type the password on each machine.
- Install *Mathematica* on a file server and run it across the network. This is the easiest way to install *Mathematica*. However, *Mathematica* runs more slowly across a network than it does on a single machine. (*Mathematica* will alert you if you attempt to start up *Mathematica* when all copies are already in use.)

After installing *Mathematica* on the server:

1. Launch *Mathematica* and type in the network license password.
2. Quit *Mathematica*.
3. Move "*Mathematica* Kernel Prefs" from the Preferences folder to the folder containing "*Mathematica* Kernel".

You can now launch *Mathematica* from any machine connected to the server.

Mathematica Developer Conference for Advanced Users Scheduled for Spring 1994

The *Mathematica* Developer Conference is scheduled for April 21–23, 1994 at the Wolfram Research headquarters in Champaign, Illinois. The conference will give advanced users an opportunity to meet Wolfram Research staff and other *Mathematica* experts to share ideas and experiences. The Developer Conference will feature workshops, panels, luncheons, a computer lab, and a series of informative, practical sessions. A major focus of this conference will be to help users create *Mathematica* packages, *MathLink* applications, *Mathematica* books, and interactive texts.

If you are interested in attending the 1994 *Mathematica* Developer Conference, send your name and address by email to conference@wri.com, or by fax to 217-398-0747.

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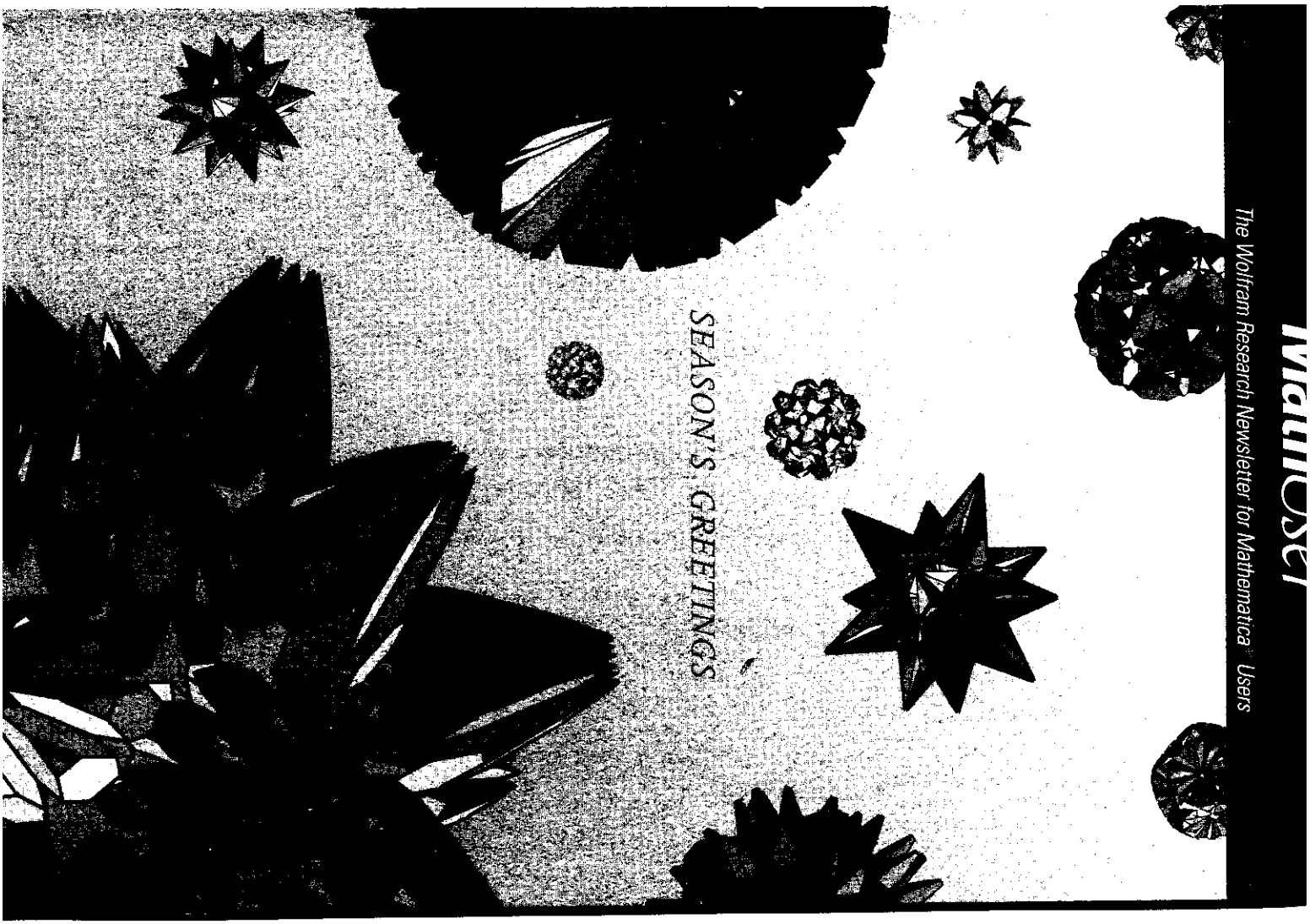


MathUser
The Wolfram Research Newsletter for Mathematica® Users

Mathematica Notebooks Coming to Unix Systems

Fall 1993

Notebooks for Unix Systems

Mathematica Days

Solving Differential Equations

Mathematica Font Development

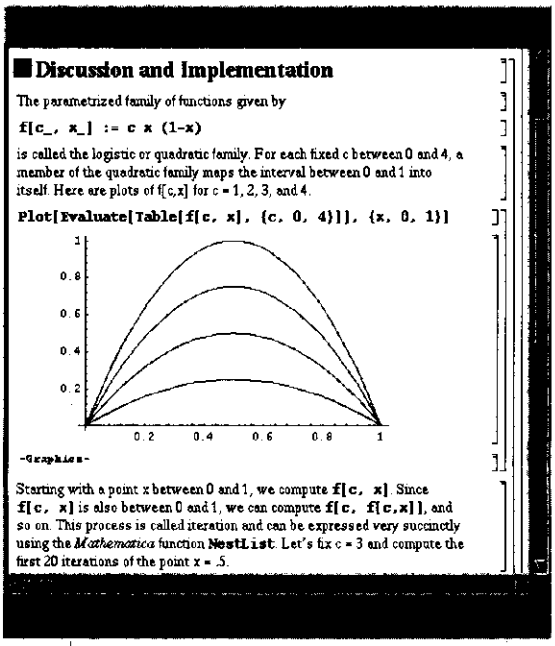
Five-year Retrospective

MathLink for Excel and LabVIEW

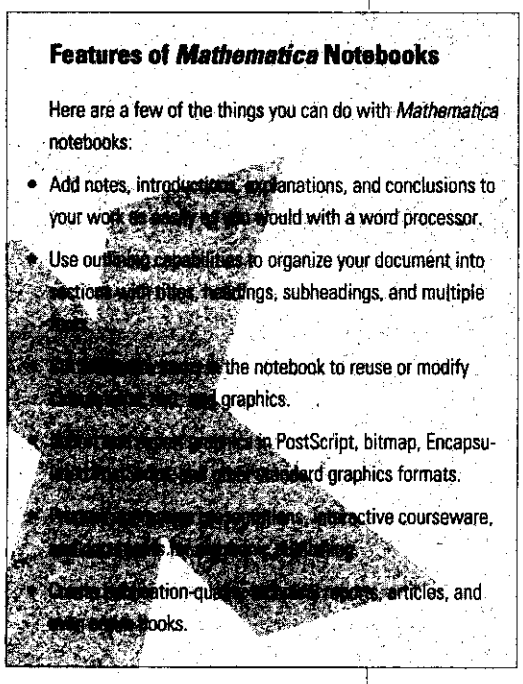
MathSource Update

Macintosh, Microsoft Windows, and NeXT users have long enjoyed the benefits of *Mathematica*'s front end, the sophisticated user interface that incorporates on-line help, a function browser, and most notably, notebooks. Now, after an extensive development effort, these features will be available to Unix users as Wolfram Research announces the release of a *Mathematica* front end for the X Window System.

Mathematica notebooks give Unix users a powerful communication tool as well as a convenient electronic medium for sharing work with *Mathematica* users on other platforms. Notebooks are designed to be compatible across multiple platforms. A notebook created on a Macintosh, for example, can be opened on a Unix machine, look almost identical, and operate in just the same way.



A Mathematica notebook under the X Window System (Motif GUI).



X Front End Features

While *Mathematica* front ends are compatible across multiple platforms, each version of the front end is also designed to take full advantage of the specific environment of each platform. So in addition to all the standard *Mathematica* notebook features that users are accustomed to (see box at left), the new X front end supports client-server memory management capabilities and gives users the ability to import GIF and X Window Dump (xwd) graphics files.

Available This Fall

The X front end will be available this fall for Sun SPARC, Silicon Graphics, Hewlett-Packard, DEC RISC, and IBM RISC computers. If you are a *Mathematica Plus* subscriber, you will automatically receive the new X front end. (The front end is complimentary for current subscribers and is not considered one of the two updates provided under the *Mathematica Plus* program.)

Customers who have not yet joined the *Mathematica Plus* program can receive the X front end by subscribing to the program. Simply submit the form that came with your copy of *Mathematica* or place a credit card order by telephone with Wolfram Research. The subcription price is printed on your license certificate and includes two *Mathematica* updates.

About *MathUser*

MathUser is published by Wolfram Research to provide news and information about *Mathematica* to registered *Mathematica* users. *MathUser* is also available free of charge to other people interested in *Mathematica*. To be added to the list of subscribers or to submit a change of address, send your address information by email to mathuser@wri.com, or call 217-398-6500. Giving your license number will help us update our records more efficiently.

Your comments and suggestions are important to us. Send letters to the editor at the address below. We are always interested in hearing ideas for topics to be covered in *MathUser*.

How to Contact Us

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Mathematica suggestions: suggestions@wri.com
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Correction

In *MathUser* #3, the ISBN given for Gerd Baumann's *Mathematica in der theoretischen Physik* is incorrect. It is ISBN 3-540-56210-9.

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1993 *MATHEMATICA* DAYS

Coming this fall to cities in the U.S. and in Europe, *Mathematica* Days are one-day seminars designed to give attendees valuable training and a practical introduction to *Mathematica*.

If you are just getting started with *Mathematica* or would like to learn more about how others in your field are using the system, *Mathematica* Days offer you the perfect opportunity. If you have colleagues who are interested in learning how *Mathematica* can benefit them at work, we encourage you to bring them as well.

Beginning with an opening address by Stephen Wolfram, each *Mathematica* Day will feature tutorials covering a range of topics (see below) and a series of panel discussions with local experts in engineering, education, and finance. Panel members will discuss how they use *Mathematica* to enhance their work. In addition, open *Mathematica* computer labs will give attendees a chance to practice new techniques and consult Wolfram Research technical staff about specific questions or applications.

Saturday, September 11
University of Michigan
Ann Arbor, Michigan

Saturday, September 18
Boston University
Boston, Massachusetts

Friday, October 22
ESIEE
Paris, France

Tuesday, October 26
The Queen Elizabeth II Conference Centre
London, England

Friday, October 29
Sheraton Frankfurt Hotel
Frankfurt, Germany

Tutorials:

Introduction to *Mathematica*—Learn to solve equations, visualize data, and manipulate polynomials, power series expansions, matrices, and graphs.

Programming with *Mathematica*—Learn to create functions and programs to customize *Mathematica* for your specific applications.

***Mathematica* Graphics—**Learn to visualize data, create custom plots, animations, and sounds, and generate presentation-quality output.

Using *Mathematica* Notebooks—Learn to create courseware, project reports, technical presentations, and publication-quality documents.

Interfacing *Mathematica* with External Programs—Learn to use *MathLink* to connect *Mathematica* to external programs.

Advanced Topics—Understand the fundamental structure of *Mathematica* in order to make maximal use of the system's power.

To register for *Mathematica* Days, simply complete and return the registration form that is included in this newsletter. If you would like us to mail a *Mathematica* Days brochure to you, call us in the U.S. at 217-398-0700, or in Europe at +44-(0)993-883400. For an electronic version of the brochure, please send an email request to conf@wri.com in the U.S., or conf-euro@wri.com in Europe.

1993 *MATHEMATICA* DAYS

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Title/Department _____ Organization _____

Street address _____ City _____ State _____

Postal/ZIP code _____ Country _____

Area code/Phone number _____ Area code/Fax number _____

Email address _____

Which Mathematica Day will you attend?

☐ Saturday, September 11, 1993
Ann Arbor, Michigan
University of Michigan
Chemistry Building

☐ Saturday, September 18, 1993
Boston University
Boston, Massachusetts
Tsai Performance Center

☐ Friday, October 22, 1993
Paris, France
ESIEE
Cite Descartes
Noisy-Le-Grand

☐ Tuesday, October 26, 1993
London, England
Queen Elizabeth II
Conference Centre
Broad Sanctuary, Westminster

☐ Friday, October 29, 1993
Frankfurt, Germany
Sheraton Frankfurt Hotel
Flughafen Terminal-Mitte

Conference fees

U.S.A.

Pre-registration fee: $20
Pre-registration forms must be received one week prior to each event.

On-site registration fee: $30
Registration begins at 8:00am.

Europe

Pre-registration fee: £20
Pre-registration forms must be received before October 12.

On-site registration fee: £30
(or equivalent local currency)
Registration begins at 8:00am.

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Please check one of the following methods of payment. Make checks payable to Wolfram Research.

☐ Check (in the U.S. only) ☐ Eurocheque (in pounds sterling) ☐ MasterCard/Visa

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Specific information about the Mathematica Day you will be attending will be forwarded to you upon receipt of this registration form.

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Workshops & Training

***Mathematica* Programming Course at the University of Erlangen**

August 10–20. For information contact Christian Jacob, c/o Chair of Programming Languages, University of Erlangen-Nuremburg, University of Erlangen, ES (IMMD II, Martensstrasse 3, 8520 Erlangen, Germany; email: jacob@informatik.uni-erlangen.de.

***Mathematica* Workshops for Variable Symbols**

Mathematica training by Nancy Blachman, author of *Mathematica: A Practical Approach*. Santa Clara, CA, August 29–September 1; Boston, MA, November 9–11. For more information call 510-843-8701; fax 510-843-8702.

***Mathematica* Presentations and Mini-**

on Technology in Collegiate Mathematics (ICTCM)

Parsippany, NJ, November 5: "*Mathematica* in Mathematics Education"; November 7: "Introduction to *Mathematica*" by staff of Wolfram Research staff; November 6–7: "Introduction to Programming with *Mathematica*" by Nancy Blachman. For more information call Kenneth Wolff of Montclair State at 201-655-5132.

Analysis and Modeling of Environmental Data with Mathematica

5th Workshop in Environmetrics: November 18–19. For information contact Ludwig C. Ries, German Association of Geoecologists, Department of Environmetrics, Wuermtalstrasse 8, 8000 Munich 70, Germany; telephone: 149 (0)30 890 3 2757.

***Mathematica* Workshop for High School Teachers**

Lampasas High School, Lampasas, TX, October 11 and 25; by Mike Mezzino (University of Houston). For information call Morris Brubaker at 512-556-6224.

If you are sponsoring a *Mathematica* workshop and wish to announce it here, please send email to info@wri.com.

MathLink Connects to Excel and LabVIEW

MathLink for Excel

Wolfram Research has developed a program that allows an Excel worksheet to be a front end to the *Mathematica* kernel.

This Excel "add-in" uses *MathLink* to make the connection to *Mathematica*. Available later this fall for use on both Macintosh and Microsoft Windows, the add-in defines a library of *Mathematica* functions that enables *Mathematica* to interact with Excel. The Excel function MATHLINK can be used directly within a worksheet to return values from *Mathematica*. MATHLINK can also serve as a foundation for building Excel macros. Several hundred such macros are included with the add-in.

In addition, the Excel add-in defines special *Mathematica* functions available from within Excel to provide rapid transmission of Excel cell ranges to and from *Mathematica*.

Applications

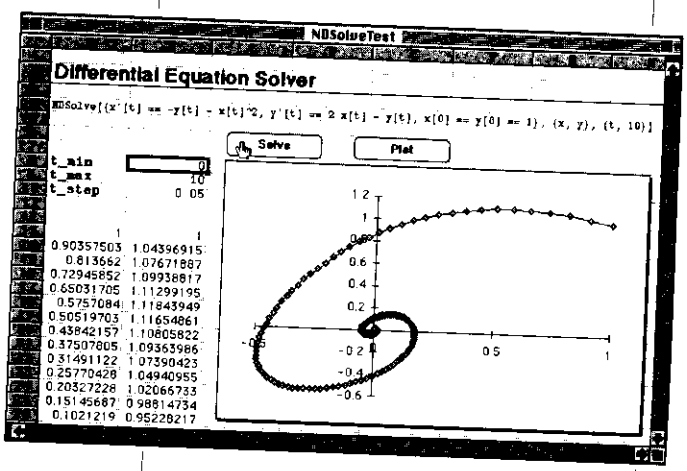
The *MathLink* add-in for Excel will be useful to people who are familiar with the Excel worksheet interface but want to use the computational power of *Mathematica*. Linking to *Mathematica* provides direct access to *Mathematica*'s extensive set of high-quality mathematical functions such as hypergeometric functions, orthogonal polynomials, and scores of special functions, as well as its arbitrary-precision arithmetic. Excel users can also now incorporate *Mathematica* programs into Excel macros, integrating the power of *Mathematica*'s programming language with the familiar spreadsheet interface. Complete *Mathematica* packages can be prepared as worksheets and then loaded into *Mathematica*. For more information about *MathLink* for Excel, contact mathlink@wri.com.

MathLink for LabVIEW

National Instruments has announced the availability of *MathLink* extensions for its LabVIEW laboratory data acquisition system. These LabVIEW VIs ("virtual instruments") communicate directly between LabVIEW and *Mathematica*.

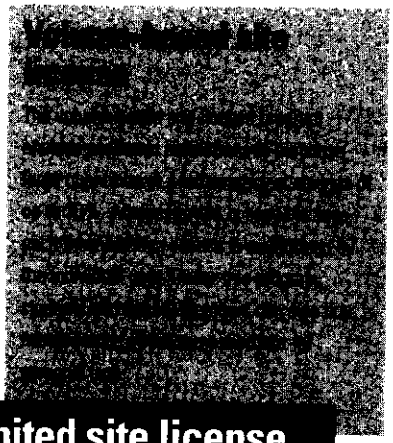
With the new VIs, which are built on top of *MathLink*, LabVIEW users can now build applications that exchange data directly with *Mathematica*. This gives LabVIEW access to all of *Mathematica*'s built-in functions and capabilities. A user can, for example, have LabVIEW send a two-dimensional array of numbers to *Mathematica*, ask *Mathematica* to apply its `Eigenvalues` function to these numbers, and then send back the answer to LabVIEW.

For more information about the LabVIEW VIs, either contact National Instruments or send a message to mathlink@wri.com.



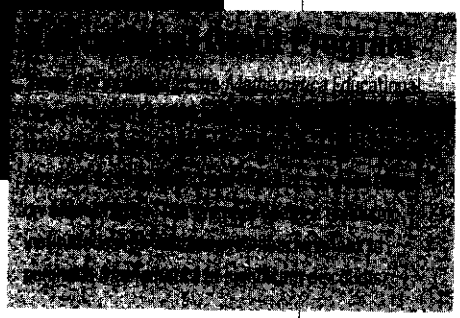
With *MathLink* for Excel, a worksheet can be set up to solve problems that are easy for *Mathematica* but difficult or impossible for Excel.

Site Licenses Increase Availability of *Mathematica* on Campus



Unlimited site license

Unlimited site licenses are a cost-effective way to provide *Mathematica* to an entire campus. We provide software masters for each different computer platform, and the school then duplicates and installs *Mathematica* on all campus computers. Regardless of how many machines are supported, a set renewal fee makes budgeting easy. Schools have the added convenience of being able to install *Mathematica* on new machines without contacting Wolfram Research. Pricing for an unlimited site license starts at $20,000 and is based on the size of the student population.



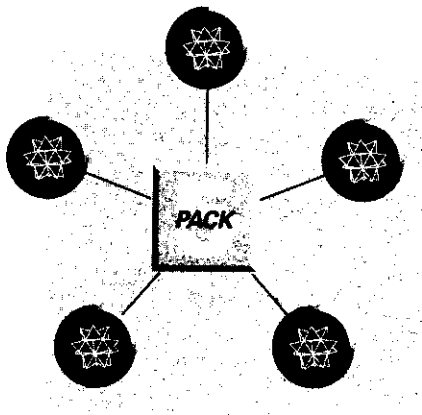
The *Mathematica* site license programs introduced last January continue to be an outstanding success, with universities, colleges, and high schools of all sizes around the world installing *Mathematica* campuswide. Now even more faculty and students are discovering the benefits of *Mathematica*'s mathematical capabilities, notebook interface, and programming language as they incorporate *Mathematica* into classwork, courseware development, and research.

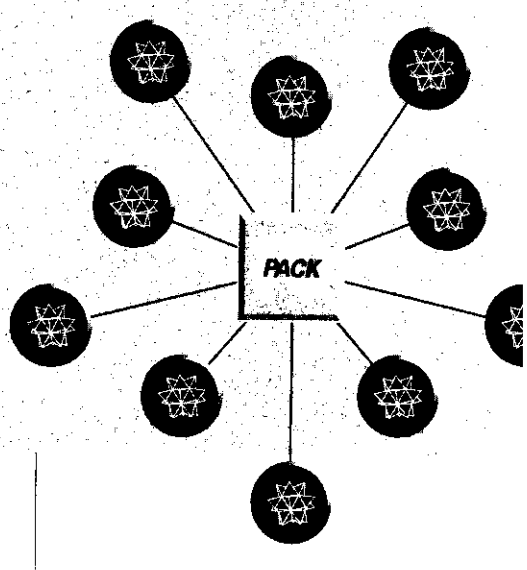
Some of the schools that have recently acquired *Mathematica* campus-wide site licenses include Virginia Polytechnic, California Air Force Academy, Colorado School of Mines, University of Houston, University of California–San Diego, University of Minnesota, Boston College, MIT, Imperial College of Science and Technology (UK), National Taiwan University, Science University of Tokyo, Justus-Liebig Universität (Giessen, Germany), Technical University of Vienna, Universidad de las Americas (Puebla, Mexico), Universitat De Barcelona, Université de Paris, and Humbolt University in Berlin.

In keeping with our continued commitment to education, these flexible site license programs are designed to meet the needs of schools of various sizes and budgets. To find out more about bringing *Mathematica* to your campus, contact Wolfram Research by telephone or send email to education@wri.com. In Europe, use education-euro@wri.com.

Workgroup Packs

At corporations and research labs, there are often teams formed to handle specific projects or research areas. Wolfram Research now offers *Mathematica* workgroup packs to make it cost-effective for whole teams in such environments to obtain single-license copies of *Mathematica* for their individual Macintosh or MS-DOS machines. Workgroup packs are available for groups of five and ten users through dealers as well as through Wolfram Research. For pricing information contact your local *Mathematica* reseller, or Wolfram Research





Differential equations are widely used in science, engineering, and numerous other areas to study processes that are continuous in space or time. The **DSolve** function in *Mathematica* finds solutions to ordinary differential equations (ODEs), systems of ODEs, and first-order partial differential equations (PDEs) using a set of powerful and general algorithms.

Mathematica reproduces virtually all the closed-form solutions found in classical reference books such as Kamke, but **DSolve** does not just contain a table of specific cases. Rather, it is a collection of [illegible] that allow *Mathematica* to solve a vastly greater range of equations than could ever be listed in a book. For example, *Mathematica* applies coordinate-independent techniques to recognize solvable equations in cases where no person could hope to stumble across the right manipulation.

Among the types of differential equations that *Mathematica* currently handles are: linear homogeneous and inhomogeneous equations, variable coefficient and nonlinear equations up to the second order, and variable coefficient and nonlinear systems of equations up to the third order. *Mathematica* Version 2.2 introduces a new package that solves first-order PDEs. Where no symbolic solution can be found, one can always use *Mathematica*'s **NDSolve** function to get a numerical approximation.

(For an outline of methods used in **DSolve**, see tutorials by A. Bocharov and by J. Keiper and D. Withoff in the *1992 Mathematica Conferences Tutorial Notes*, and the article by A. Bocharov in the Spring 1993 *Mathematica Journal*.)

Here is a fairly straightforward inhomogeneous second-order ODE that `DSolve` handles immediately:

```
DSolve[x^2 y''[x]+x y'[x] == 4 y[x]+4 x^2, y[x], x]
```

$$\{\{y[x] \to \frac{C[1]}{x^2} + x^2\, C[2] + x^2\, \text{Log}[x]\}\}$$

After loading the package `Calculus`DSolve`` *Mathematica* can solve many more differential equations:

```
<<Calculus`DSolve`

DSolve[x y''[x]+(1-x^2) y'[x]-x y[x] == 0, y[x], x]
```

$$\{\{y[x] \to \frac{E^{x^2/4}\, \text{BesselI}[0, \frac{x^2}{4}]\, C[1]}{\text{Sqrt}[Pi]} + \frac{E^{x^2/4}\, \text{BesselK}[0, \frac{-x^2}{4}]\, C[2]}{\text{Sqrt}[Pi]}\}\}$$

To solve this system of nonlinear ODEs by hand would be a daunting task:

```
DSolve[{u'[x] == u[x] (-v[x]^2 + w[x]),
        v'[x] == w[x]^2 - (v[x]^2 w[x]),
        w'[x] == 2 v[x] w[x] (w[x] - v[x]^2)},
       {u[x], v[x], w[x]}, x]
```

$$\{\{u[x] \to E^{x\, C[2]}\, C[1],\ w[x] \to C[2] + C[2]\, \text{Tan}[x\, C[2]^{3/2} + C[3]]^2,\ v[x] \to \text{Sqrt}[C[2]]\, \text{Tan}[x\, C[2]^{3/2} + C[3]]\}\}$$

A new package symbolically solves first-order PDEs through Lie symmetry reduction:

```
<<Calculus`PDSolve1`

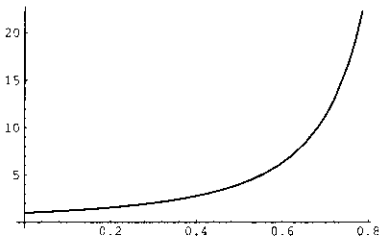
DSolve[ - x y z + z^2 D[w[x, y, z], z] +
y^2 D[w[x, y, z], y] + x^2 D[w[x, y, z], x] == 0 ,
w[x, y, z], {x, y, z}]
```

$$\{\{w[x, y, z] \to -\left(\frac{x\, y^2\, z\, \text{Log}[\frac{x}{y}]}{-(x\, y) + y^2 + x\, z - y\, z}\right) + \frac{x\, y\, z^2\, \text{Log}[\frac{x}{z}]}{-(x\, y) + x\, z + y\, z - z^2} + C[1][\frac{1}{x} - \frac{1}{y}, \frac{1}{x} - \frac{1}{z}]\}\}$$

This Painleve equation has no closed form solution, but `NDsolve` gives a numerical approximation:

```
NDSolve[{y''[x] == 6 y[x]^2 + x, y[0] == 1, y'[0] == 2},
y[x], {x, 0, Pi/4}]
{{y[x] -> InterpolatingFunction[{0., 0.785398}, <>][x]}}


Plot[y[x] /. %, {x, 0, Pi/4}]
```



Mathematica History

June 23, 1993 marked the fifth anniversary of the release of *Mathematica*, and we took this opportunity to reflect on the events and achievements of the past five years. Below are a few of the highlights of *Mathematica*'s history.

1986

Stephen Wolfram begins the development of *Mathematica*

1987

Wolfram Research, Inc. founded

1988

June 23rd—*Mathematica* Version 1.0 officially announced at press conference in Santa Clara, CA, attended by Apple Computer, IBM, NeXT, Silicon Graphics, Sun Microsystems, and others. "The importance of the program cannot be overlooked ... it so fundamentally alters the mechanics of mathematics," said the New York Times.

Mathematica 1.0 for the Macintosh released immediately following announcement

Stephen Wolfram's book, *Mathematica: A System for Doing Mathematics by Computer*, published by Addison-Wesley and becomes a technical book bestseller

Calculus & *Mathematica* course begins at University of Illinois

1989

Mathematica Version 1.2 is available for 9 Unix platforms as well as for the Macintosh and MS-DOS

Mathematica wins 8 industry awards to date

Engineering becomes the single most common use of *Mathematica*, followed by computer science, the physical sciences and mathematics

Programming in Mathematica by Roman Maeder published

Mathematica is in use on 6 continents

1990

First *Mathematica* Conference held in Redwood City, CA

Company is reorganized to emphasize direct sales rather than distribution through hardware vendors

Japan grows to nearly 10% of the *Mathematica* market

Wolfram Research (UK) Ltd. founded

Mathematica Educational Grant Program launched

Mathematica Student Version released

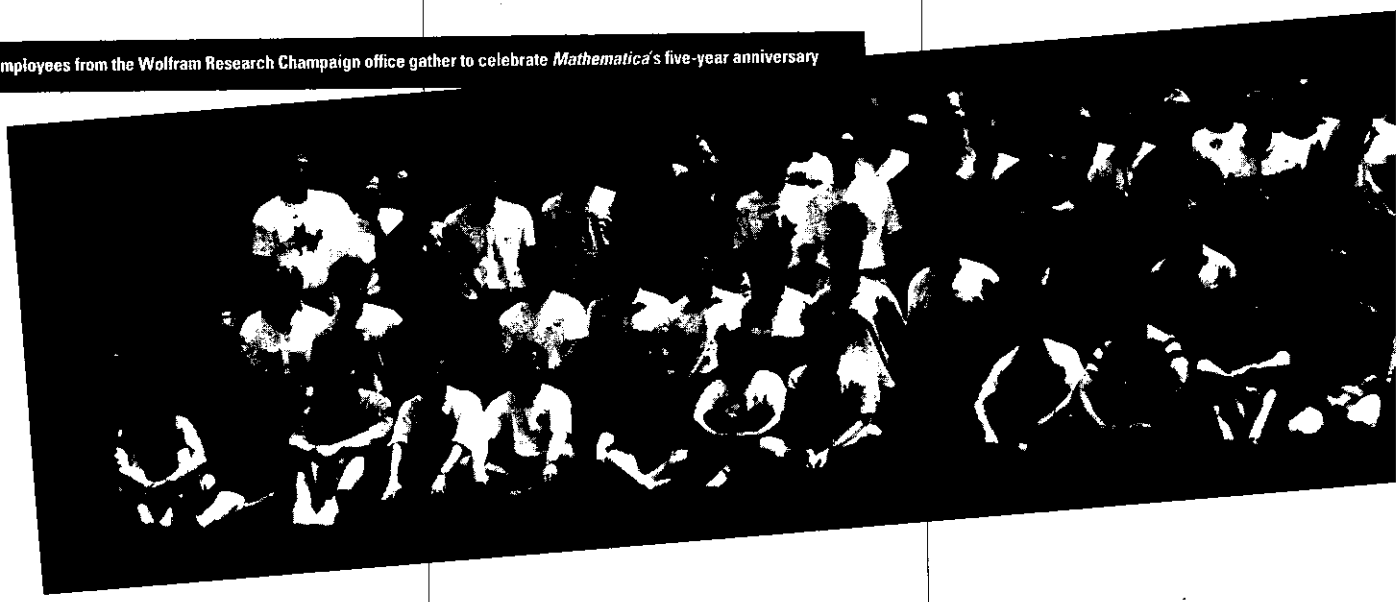
First issue of *The Mathematica Journal* published

First complete book (Gray & Glynn) published on paper and CD-ROM entirely with the *Mathematica* front end

MathTensor announced, first major third-party package developed for users with *Mathematica*

Mathematica is in use in more than 50 countries

Employees from the Wolfram Research Champaign office gather to celebrate *Mathematica*'s five-year anniversary



1991

Second edition of Stephen Wolfram's *Mathematica* book published

Mathematica Conference held in San Francisco

Mathematica 2.0 released, adding 283 new built-in functions to the system

Mathematica Version 2.0 repeatedly praised in industry and scientific magazines. American Scientist writes: "*Mathematica* is not just a computer program; it is a cultural artifact, a medium of self-expression and a consuming passion."

MathLink communication capabilities available

Mathematica is in use at all 50 of the largest Ph.D.-granting universities in the U.S.

First issue of *Mathematica in Education* newsletter published

Mathematica is in use at 13 of the 15 departments of the U.S. government

Stephen Wolfram's *Mathematica* book published in Japanese

Total of 13 books on *Mathematica* have been published

Mathematica appears in the credits of two major feature films

1992

Mathematica 2.0 for Microsoft Windows released

Mathematica worldwide conferences held in Boston, Rotterdam, and Tokyo

Version 2.1 released: faster, lower memory requirements, new packages, and extensive enhancements of *MathLink*

Japanese-language version of *Mathematica* released for NEC PC 9801

Total of 26 versions of *Mathematica* are available for different kinds of computer systems

Mathematica wins 37 industry awards to date

Mathematica academic site purchase programs launched

Over 400 colleges and universities now have *Mathematica* labs

Mathematica is in use at all the top 10 brokerage firms in the U.S.

MathSource goes on line

Mathematica starts to become widely used in high schools around the world

Stephen Wolfram's *Mathematica* book published in German

Total of 30 books on *Mathematica* have been published

Mathematica is permanently on display at several major science museums around the world

1993

Version 2.2 released: partial differential equations, sparse linear systems, online manuals, and a function browser

First *Mathematica* Developer Conference held at Wolfram Research, Inc., in Champaign

MathSource averages nearly 2000 sessions a week, with email and ftp access

Mathematica books have appeared in 9 languages

Mathematica is referenced explicitly in 383 published scientific papers, and is mentioned in thousands more

Mathematica is in use at 49 of the top 50 Global Fortune 500 companies

Mathematica is being taught as a programming language to computer science students in many universities

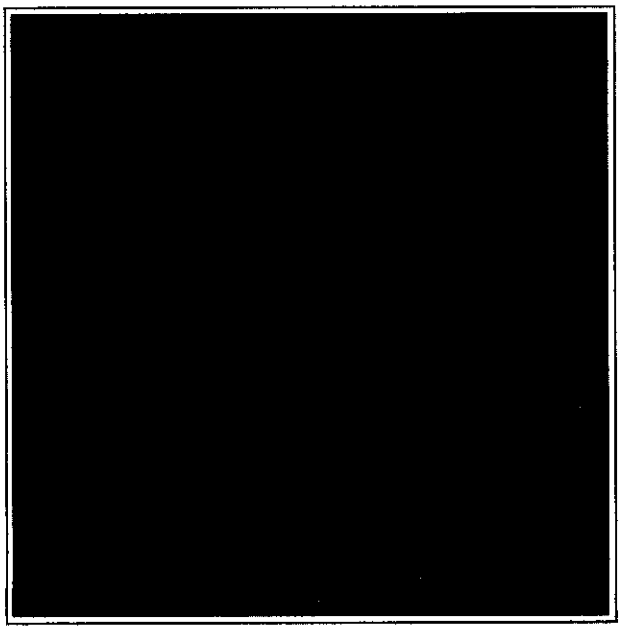
Total of 48 books on *Mathematica* have been published

Mathematica is in use in 96 countries

Estimates indicate that well over 1 million people have used *Mathematica* to date

and more to come...

Development of a Mathematica Font



Current versions of *Mathematica* leave the task of producing final typeset mathematical equations to other programs such as TeX. But for several years now, Wolfram Research has been developing an interactive typesetting capability to be integrated directly into *Mathematica*. As a part of that process, we have found it necessary to design a new mathematical font that fits better with common typefaces that are widely used on computers today, such as Times Roman and Palatino. Our intention is for this new font to contain as complete a collection of mathematical symbols as possible. On these pages we present our current designs for some of these symbols. All the characters shown here will also be available in boldface form. In addition to the characters shown here, there will be complete Gothic, script, and doubled alphabets in regular and bold weights as well as a variety of other characters.

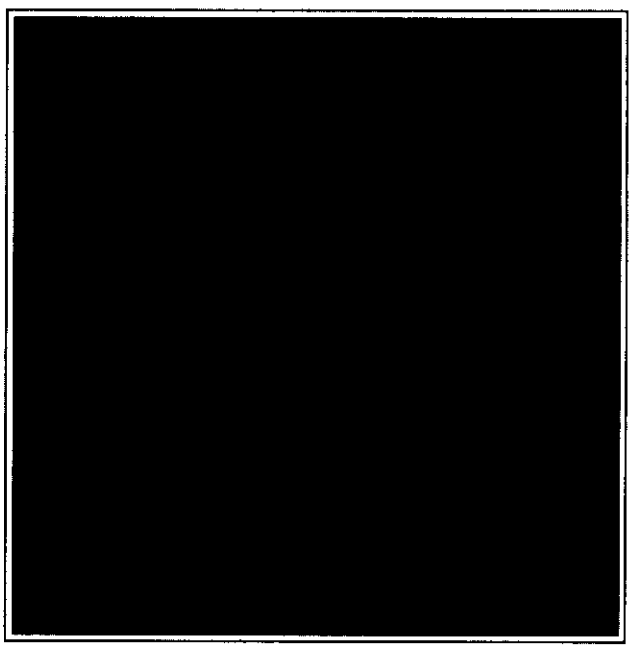
There will be several ways to enter each character. α, for example, can be typed either as \(Alpha), the sequence ESC a ESC (on most keyboards, ESC stands for ESC), or picked from a palette. (For TeX users, typing the sequence ESC \alpha ESC will also work.)

We plan to make our font the definitive typeface for mathematical typesetting, and we encourage your involvement in its development. We are very interested in receiving feedback from *Mathematica* users about symbols that should be included, symbol names, and the rendering of the symbols shown here. Please send your comments by email to fonts@wri.com (NeXT mail accepted) or by fax to 217-398-0747.

A \(CapitalAlpha)	Ξ \(CapitalXi) ESC X ESC	γ \(Gamma) ESC g ESC	ξ \(Xi) ESC x ESC	∞ \(Infinity) ESC inf ESC
B \(CapitalBeta)	O \(CapitalOmicron)	δ \(Delta) ESC d ESC	o \(Omicron) ESC om ESC	ϕ \(EmptySet) ESC es ESC
Γ \(CapitalGamma) ESC G ESC	Π \(CapitalPi) ESC P ESC	ϵ \(Epsilon) ESC e ESC	π \(Pi) ESC p ESC	∂ \(Partial) ESC pa ESC
Δ \(CaptalDelta) ESC D ESC	P \(CapitalRho)	ε \(CurlyEpsilon) ESC ce ESC	ρ \(Rho) ESC r ESC	∇ \(Del) ESC del ESC
E \(CapitalEpsilon)	Σ \(CapitalSigma) ESC S ESC	ζ \(Zeta) ESC z ESC	σ \(Sigma) ESC s ESC	$\int$ \(Integral) ESC int ESC
Z \(CapitalZeta)	T \(CapitalTau)	η \(Eta) ESC eta ESC	τ \(Tau) ESC t ESC	$\oint$ \(LoopIntegral) ESC lint ESC
H \(CapitalEta)	Υ \(CapitalUpsilon) ESC U ESC	θ \(Theta) ESC th ESC	υ \(Upsilon) ESC u ESC	Σ \(Sum) ESC sum ESC
Θ \(CapitalTheta) ESC Th ESC	Φ \(CapitalPhi) ESC Ph ESC	ϑ \(CurlyTheta) ESC cth ESC	ϕ \(Phi) ESC ph ESC	Π \(Product) ESC prod ESC
I \(CapitalIota)	X \(CapitalChi)	ι \(Iota) ESC i ESC	φ \(CurlyPhi) ESC cph ESC	∐ \(Coproduct)
K \(CapitalKappa)	Ψ \(CapitalPsi) ESC Ps ESC	κ \(Kappa) ESC k ESC	χ \(Chi) ESC ch ESC	∀ \(ForAll) ESC fa ESC
Λ \(CapitalLambda) ESC L ESC	Ω \(CapitalOmega) ESC O ESC	λ \(Lambda) ESC l ESC	ψ \(Psi) ESC ps ESC	∃ \(Exists) ESC ex ESC
M \(CapitalMu)	α \(Alpha) ESC a ESC	μ \(Mu) ESC m ESC	ω \(Omega) ESC o ESC	∄ \(NotExists) ESC !ex ESC
N \(CapitalNu)	β \(Beta) ESC b ESC	ν \(Nu) ESC n ESC	ϖ \(CurlyPi) ESC cp ESC	¬ \(Hook) ESC ho ESC

Note: In addition to the symbols shown here, there will be various bracketing characters, primes, dots, and so on

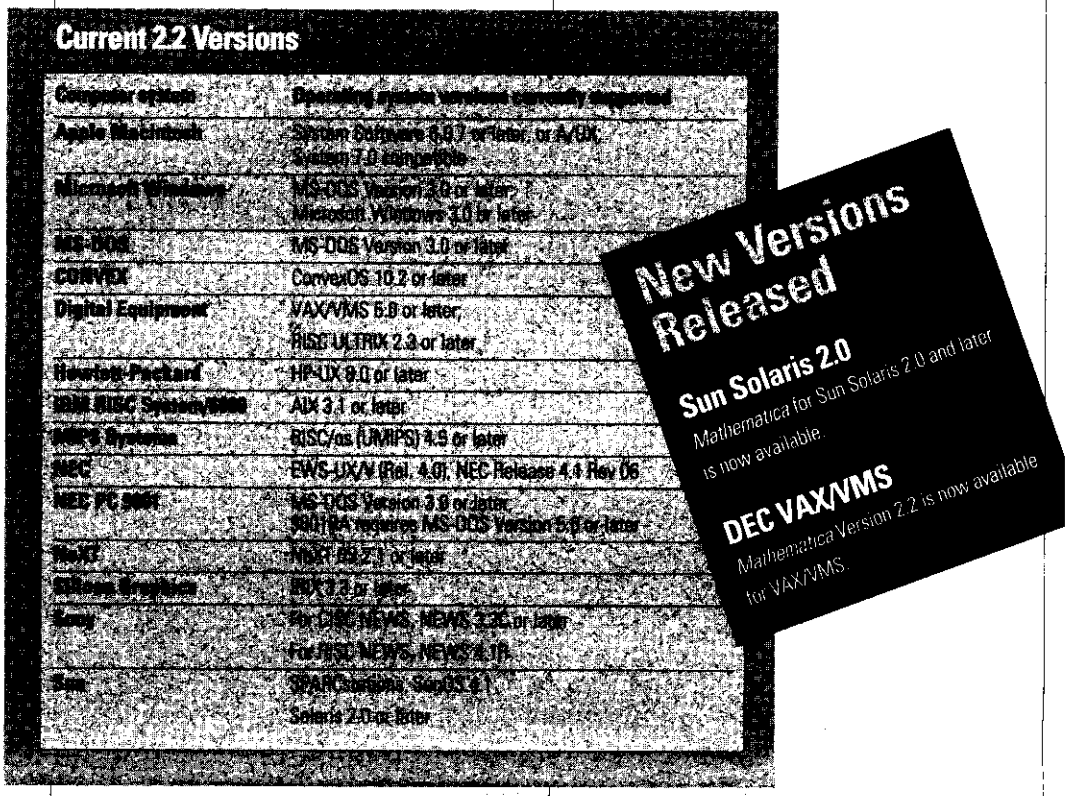
$\pm$ \(PlusMinus) x+-x	$\vee$ \(Vee) xVx	$>$ \(Greater)	$\succeq$ \(SucceedsEqual)	$\simeq$ \(TildeEqual) x-~x	$\therefore$ \(Therefore)	$\rightarrow$ \(RightArrow) x->x	$\Leftarrow$ \(DoubleLeftArrow)	$\Longleftrightarrow$ \(DoubleLongLeftRightArrow) x<==>x
$\mp$ \(MinusPlus) x-+x	$\wedge$ \(Wedge) x^x	$\not>$ \(NotGreater) x!>x	$\gtrsim$ \(SucceedsTilde)	$\not\simeq$ \(NotTildeEqual) x!~-x	$\because$ \(Because)	$\leftrightarrow$ \(LeftRightArrow) x<->x	$\Rightarrow$ \(DoubleRightArrow) x=>x	$\blacksquare$ \(QED)
$\oplus$ \(CirclePlus) x0+x	$\lhd$ \(LeftTriangle)	$\geq$ \(GreaterEqual) x>=x	$\not\succ$ \(NotSucceeds)	$\approx$ \(EqualTilde) x=-x	$\rightharpoonup$ \(RightVector) xvecx	$\uparrow$ \(UpArrow) x^x	$\Leftrightarrow$ \(DoubleLeftRightArrow) x<=>x	$\Lsh$ \(Escape) xESCx
$\ominus$ \(CircleMinus) x0-x	$\trianglelefteq$ \(LeftTriangleEqual)	$\not\geq$ \(NotGreaterEqual) x!>=x	$\subset$ \(Subset) xsubx	$\cong$ \(TildeFullEqual)	$\leftharpoondown$ \(LeftVector)	$\downarrow$ \(DownArrow) xvx	$\Uparrow$ \(DoubleUpArrow)	$\aleph$ \(Aleph)
$\times$ \(Cross) x*x	$\rhd$ \(RightTriangle)	$\gtrsim$ \(GreaterTilde) x>~x	$\subseteq$ \(SubsetEqual) xsub=x	$\approx$ \(TildeTilde) x~~x	$\leftrightharpoons$ \(LeftRightVector)	$\updownarrow$ \(UpDownArrow) x^vx	$\Downarrow$ \(DoubleDownArrow)	$\hbar$ \(HBar)
$\otimes$ \(CircleCross) x0*x	$\trianglerighteq$ \(RightTriangleEqual)	$\not\gtrsim$ \(NotGreaterTilde) x!>~x	$\supset$ \(Superset) xsupx	$\doteqdot$ \(HumpEqual) x=~x	$\mapsto$ \(RightTackArrow)	$\longleftarrow$ \(LongLeftArrow) x<--x	$\Updownarrow$ \(DoubleUpDownArrow)	ℓ \(ScriptL) xscl x
$\cdot$ \(Dot) x.x	$\rightleftharpoons$ \(Equilibrium)	$\equiv$ \(Congruent) x===x	$\supseteq$ \(SupersetEqual) xsup=x	$\doteq$ \(DotEqual) x.=x	$\mapsfrom$ \(LeftTackArrow)	$\longrightarrow$ \(LongRightArrow) x-->x	$\Lleftarrow$ \(DoubleLongLeftArrow)	$\Re$ \(GothicCapitalR) xgoRx
$\odot$ \(CircleDot) x0.x	$\neq$ \(NotEqual) x!=x	$\ll$ \(LessLess) x<<x	$\sqsubset$ \(SquareSubset)	$\propto$ \(Proportional) xpropx	$\leftarrow$ \(LeftArrow) x<-x	$\longleftrightarrow$ \(LongLeftRightArrow) x<-->x	$\Longrightarrow$ \(DoubleLongRightArrow) x==>x	$\mathbb{Z}$ \(DoubledZ) xdbzx
$\div$ \(DivisionSign) xdivx	$<$ \(Less)	$\gg$ \(GreaterGreater) x>>x	$\sqsubseteq$ \(SquareSubsetEqual)	$\perp$ \(Perpendicular) xperpx				
$-$ \(Minus)	$\not<$ \(NotLess) x!<x	$\prec$ \(Precedes)	$\sqsupset$ \(SquareSuperset)	$\wr$ \(WreathProduct)				
$-$ \(Dash) x-x	$\leq$ \(LessEqual) x<=x	$\preceq$ \(PreceedsEqual)	$\sqcap$ \(SquareIntersection)	$\in$ \(Element) xelemx				
$—$ \(LongDash) x--x	$\not\leq$ \(NotLessEqual) x!<=x	$\precsim$ \(PreceedsTilde)	$\sqcup$ \(SquareUnion)	$\notin$ \(NotElement) x!elemx				
$\cap$ \(Intersection) xinterx	$\lesssim$ \(LessTilde) x<~x	$\not\prec$ \(NotPreceeds)	$\sim$ \(Tilde)	$\ni$ \(Member) xmemx				
$\cup$ \(Union) xunx	$\not\lesssim$ \(NotLessTilde) x!<~x	$\succ$ \(Succeeds)	$\not\sim$ \(NotTilde) x!~x	$\not\ni$ \(NotMember) x!memx				



Technical Support Policy

Wolfram Research provides technical support for the current and immediately previous versions of *Mathematica*.

The current shipping version is 2.2. If you are using *Mathematica* on a computer system for which Version 2.2 is not available (see chart), and plan to upgrade to a supported computer system, just contact Wolfram Research to transfer your *Mathematica* license to the new system.



New Versions under Development

Wolfram Research is continually working on making *Mathematica* available on a wide range of computer systems. Our efforts in this direction typically begin long before a new system is publicly announced. Here are a few of the systems on which *Mathematica* is currently under development. Specific release dates and pricing have not yet been set.

Windows NT
Versions of *Mathematica* are being developed for Windows NT on the three architectures that Windows NT supports: Intel, MIPS, and DEC Alpha.

DEC Alpha
An OSF Unix version of *Mathematica* for Digital's Alpha architecture is being built.

PowerPC
We are working closely with Apple Computer to develop a version of *Mathematica* for the upcoming PowerPC processor-based Macintosh systems.

NEXTSTEP Intel 486
We received many requests from customers to produce a version of *Mathematica* running under NEXTSTEP for Intel. This version is now being tested.

OS/2
Mathematica Version 2.2 for MS-DOS currently runs under OS/2 v2.0. *Mathematica* for Microsoft Windows runs under OS/2 v2.1. Thanks to the significant user interest generated in response to our inquiry in the last issue of *MathUser*, planning for a native port to OS/2 has begun.